

Power MOSFET



N-Channel MOSFET

FEATURES

- Lower gate charge Q_g results in simpler drive requirements
- Improved gate, avalanche, and dynamic dV/dt ruggedness
- Fully characterized capacitance and avalanche voltage
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


 Available
RoHS*
 Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supplies
- High speed power switching

PRODUCT SUMMARY	
V_{DS} (V)	500
$R_{DS(on)}$ (Ω)	$V_{GS} = 10\text{ V}$ 0.450
Q_g max. (nC)	81
Q_{gs} (nC)	20
Q_{gd} (nC)	36
Configuration	Single


ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free	IRFB13N50APbF

ABSOLUTE MAXIMUM RATINGS ($T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted)				
PARAMETER	SYMBOL		LIMIT	UNIT
Drain-source voltage	V_{DS}		500	V
Gate-source voltage	V_{GS}		± 30	
Continuous drain current	V_{GS} at 10 V	$T_C = 25\text{ }^\circ\text{C}$	14	A
		$T_C = 100\text{ }^\circ\text{C}$	9.1	
Pulsed drain current ^a	I_{DM}		56	
Linear derating factor			2.0	$W/^\circ\text{C}$
Single pulse avalanche energy ^b	E_{AS}		560	mJ
Repetitive avalanche current ^a	I_{AR}		14	A
Repetitive avalanche energy ^a	E_{AR}		25	mJ
Maximum power dissipation	$T_C = 25\text{ }^\circ\text{C}$		P_D 250	W
Peak diode recovery dV/dt ^c			dV/dt 9.2	V/ns
Operating junction and storage temperature range	T_J, T_{stg}		-55 to +150	$^\circ\text{C}$
Soldering recommendations (peak temperature) ^d	For 10 s		300	
Mounting torque	6-32 or M3 screw		10	lbf · in
			1.1	N · m

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 5.7\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_{AS} = 14\text{ A}$, $dV/dt = 7.6\text{ V/ns}$ (see fig. 12a)
- $I_{SD} \leq 14\text{ A}$, $dI/dt \leq 250\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case

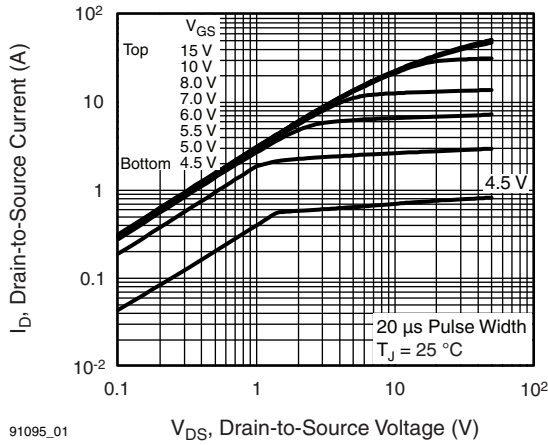
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	62	°C/W
Case-to-sink, flat, greased surface	R_{thCS}	0.50	-	
Maximum junction-to-case (drain)	R_{thJC}	-	0.50	

SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Static							
Drain-source breakdown voltage	V_{DS}	$V_{GS} = 0\text{ V}$, $I_D = 250\text{ }\mu\text{A}$	500	-	-	V	
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = 1\text{ mA}$	-	0.55	-	V/°C	
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	2.0	-	4.0	V	
Gate-source leakage	I_{GSS}	$V_{GS} = \pm 30\text{ V}$	-	-	± 100	nA	
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 500\text{ V}$, $V_{GS} = 0\text{ V}$	-	-	25	μA	
		$V_{DS} = 400\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	-	250		
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$, $I_D = 8.4\text{ A}^b$	-	-	0.450	Ω	
Forward transconductance	g_{fs}	$V_{DS} = 50\text{ V}$, $I_D = 8.4\text{ A}$	8.1	-	-	S	
Dynamic							
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = 25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5	-	1910	-	μF	
Output capacitance	C_{oss}		-	290	-		
Reverse transfer capacitance	C_{rss}		-	11	-		
Output capacitance	C_{oss}	$V_{GS} = 0\text{ V}$	$V_{DS} = 1.0\text{ V}$, $f = 1.0\text{ MHz}$	-	2730	μF	
			$V_{DS} = 400\text{ V}$, $f = 1.0\text{ MHz}$	-	82		-
Effective output capacitance	$C_{oss\text{ eff.}}$	$V_{DS} = 0\text{ V to } 400\text{ V}^c$	-	160	-		
Total gate charge	Q_g	$V_{GS} = 10\text{ V}$	$I_D = 14\text{ A}$, $V_{DS} = 400\text{ V}$, see fig. 6 and 13 ^b	-	-	81	nC
Gate-source charge	Q_{gs}			-	-	20	
Gate-drain charge	Q_{gd}			-	-	36	
Turn-on delay time	$t_{d(on)}$			$V_{DD} = 250\text{ V}$, $I_D = 14\text{ A}$, $R_g = 7.5\text{ }\Omega$, see fig. 10 ^b	-	15	-
Rise time	t_r	-	39		-		
Turn-off delay time	$t_{d(off)}$	-	39		-		
Fall time	t_f	-	31		-		
Gate input resistance	R_g	$f = 1\text{ MHz}$, open drain	0.5	-	2.1	Ω	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	14	A	
Pulsed diode forward current ^a	I_{SM}		-	-	56		
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = 14\text{ A}$, $V_{GS} = 0\text{ V}^b$	-	-	1.5	V	
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}$, $I_F = 14\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$	-	370	550	ns	
Body diode reverse recovery charge	Q_{rr}		-	4.4	6.5	μC	
Body diode reverse recovery current	I_{RRM}		-	21	31	A	
Forward turn-on time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)					

Notes

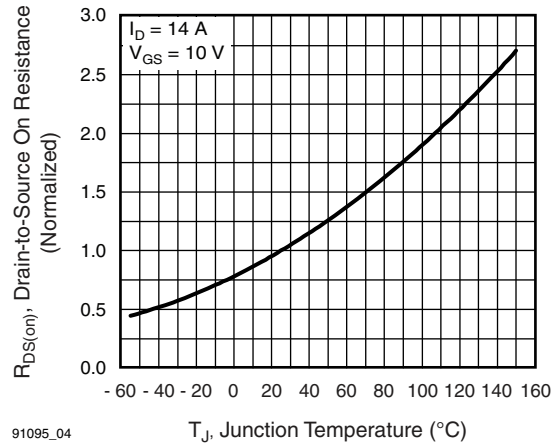
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$
- $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS}

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



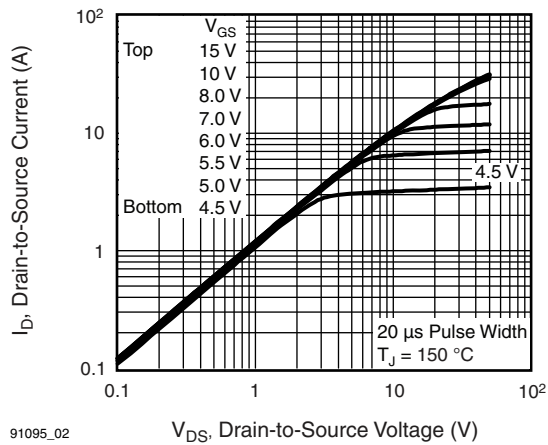
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Fig. 1 - Typical Output Characteristics



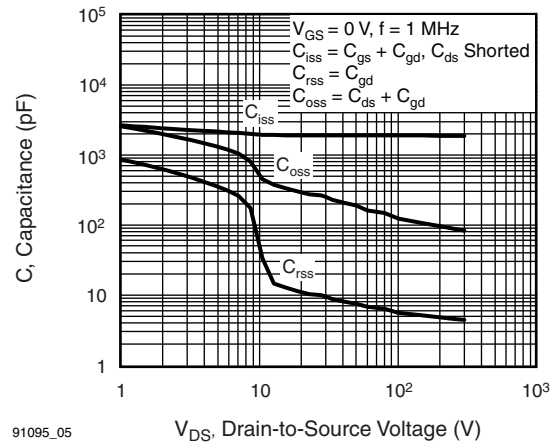
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Fig. 4 - Normalized On-Resistance vs. Temperature



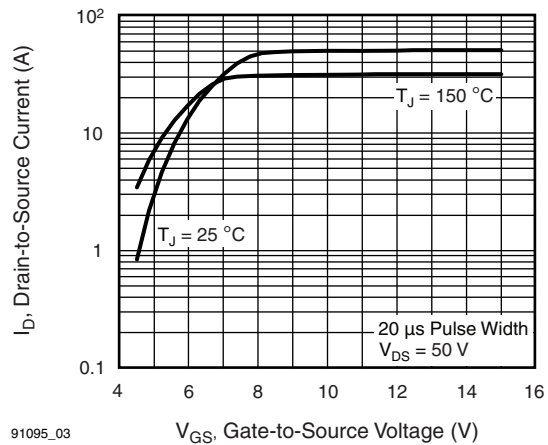
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Fig. 2 - Typical Output Characteristics



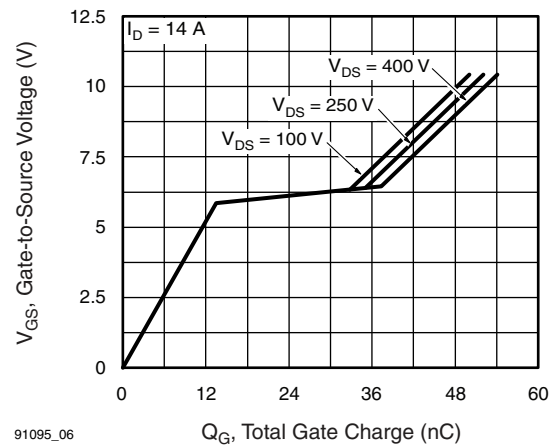
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Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



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Fig. 3 - Typical Transfer Characteristics



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Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

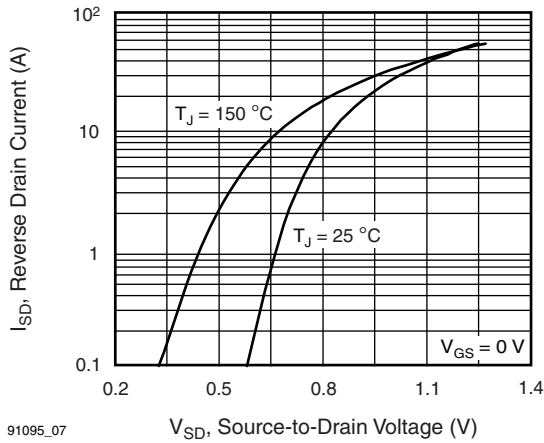


Fig. 7 - Typical Source-Drain Diode Forward Voltage

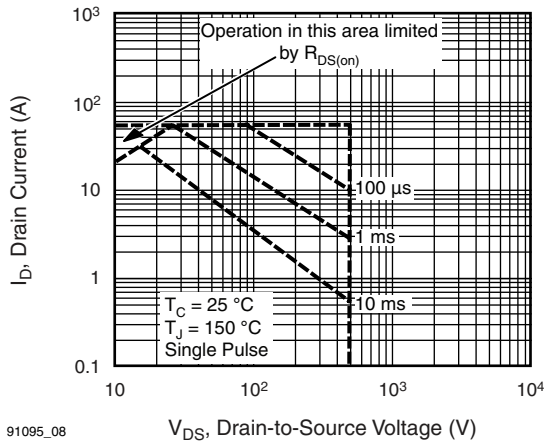


Fig. 8 - Maximum Safe Operating Area

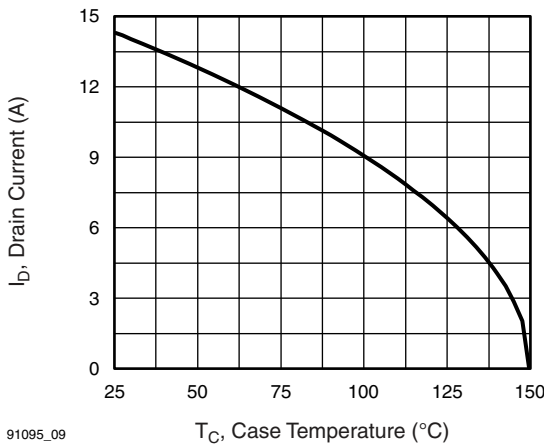


Fig. 9 - Maximum Drain Current vs. Case Temperature

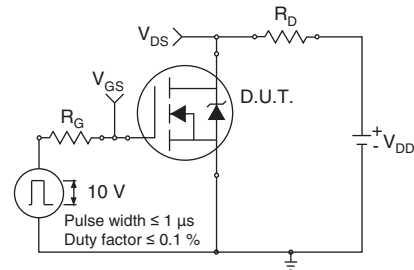


Fig. 10a - Switching Time Test Circuit

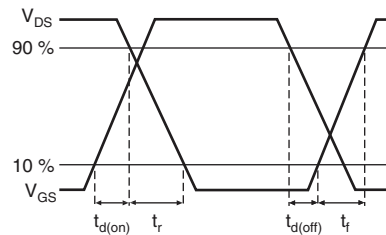
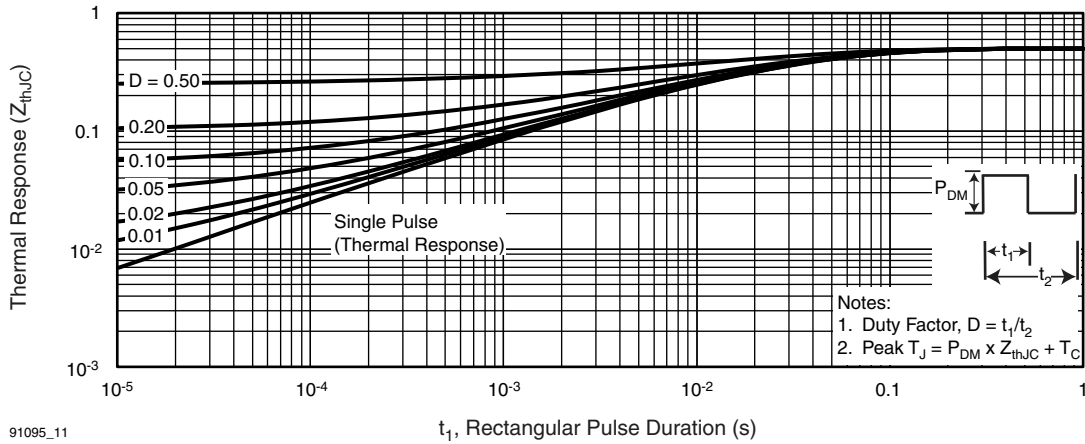


Fig. 10b - Switching Time Waveforms



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Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

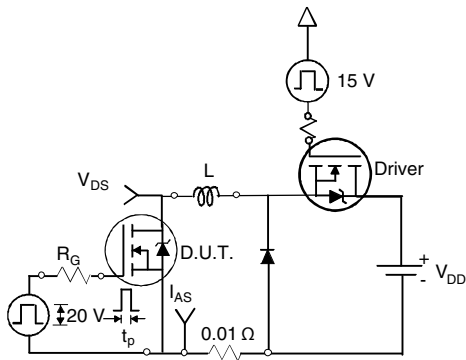


Fig. 12a - Unclamped Inductive Test Circuit

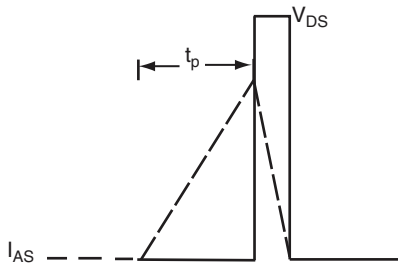


Fig. 12b - Unclamped Inductive Waveforms

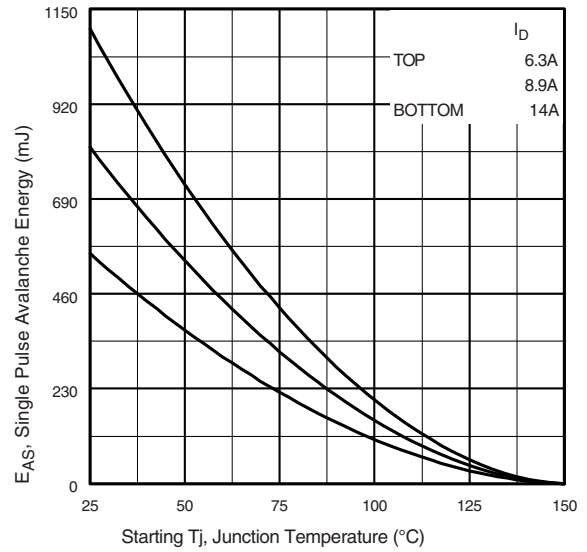


Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 13a - Basic Gate Charge Waveform

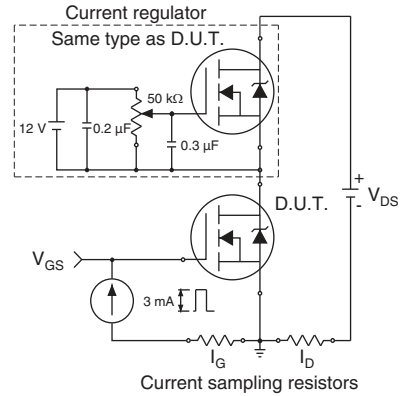
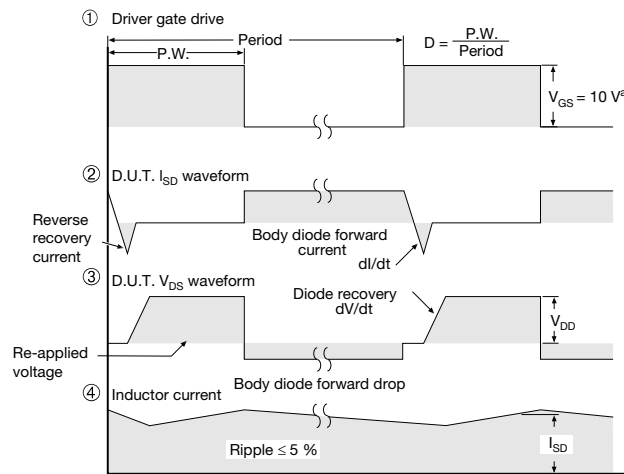
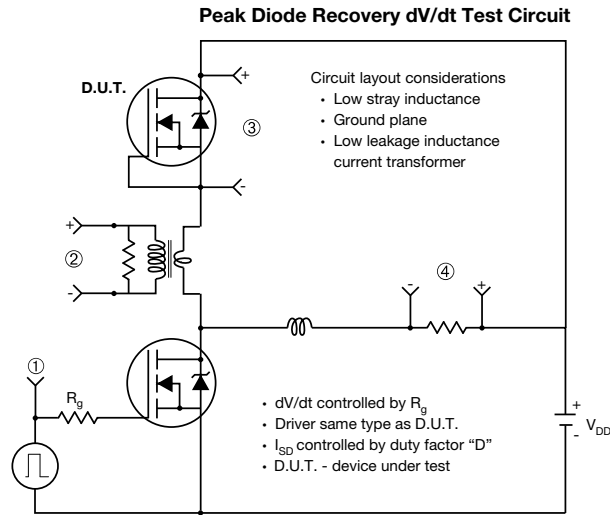


Fig. 13b - Gate Charge Test Circuit



Note
a. $V_{GS} = 5V$ for logic level devices

Fig. 14 - For N-Channel

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TO-220-1



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
J(1)	2.41	2.92	0.095	0.115
L	13.36	14.40	0.526	0.567
L(1)	3.33	4.04	0.131	0.159
$\varnothing P$	3.53	3.94	0.139	0.155
Q	2.54	3.00	0.100	0.118

ECN: E21-0621-Rev. D, 04-Nov-2021
DWG: 6031

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM



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